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The Changing Retail Structure of Metropolitan Regions

by CLAIR JAMES REILLY*

The vast population movements from farm to town and from city to the outlying regions have been and will continue to be major forces in the changing retail structure of metropolitan areas. This article develops the early retail trade pattern in Philadelphia, the linkages of the central district retail estalishments, the evolution of the shopping center, the characteristics and trends of shopping centers in the nation and in Philadelphia, and presents a statement of the importance of market analysis, the relationship of buying habits to retail trade areas, and central city shopping center retail trade comparisons.

SOME of the underlying reasons for changes in and the growth of the retailing structure are increases in population, purchasing power, and productivity. These affect the nature and location of retailing activities in the central business districts and outlying areas. There has been a definite movement of population to the suburbs in the past, and this trend is likely to continue in the future. The suburbs have grown 210 percent, for example, while the nation has grown 64 percent from 1910 to 1950.[1]

In order to appraise the change in location of retailing activities, the characteristics of population and their buying power must be considered. These factors are discussed in more detail in other sections of this report.

Home ownership is another important characteristic of population. At present about fifty-nine percent of all families own homes as compared with 41 percent in 1940.[2] Most of the near-million homes built each year since 1950 are in the suburbs. For example, in the Philadelphia standard metropolitan area, new residential construction in the suburbs was 25,289 for 1954 as compared with 21,383 in 1950.[3]

The characteristics of the suburbanite and the city dweller should also be considered. The people in the outlying areas are influential customers. Their preferences for functional furniture and costume jewelry, for example, are copied by residents closer to the center of the city. On the other hand, the city dweller tends to be an important purchaser of general merchandise.

With respect to income, the suburban family has more buying power than those in the city. For example, family income was $6,478 for Philadelphia as compared with $8,479 for Montgomery County in 1956.[4] (See Table 1). The resident in the suburbs is accumulating property. According to Professor Henry Wallick of Yale University, the interurbanite is also becoming a man of substance in terms of increasing equities in house and appliances.[5] This acquisition of wealth is also indicated in a Philadelphia study. Of those families possessing appliances in Philadelphia, about 40 percent have an automatic washer as compared with 50 percent for those in thirteen counties outside Philadelphia in 1956.[6] Also about 28 percent

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1"Suburbia—Exurbia—Urbia," **Newsweek,** April 1, 1957, p. 36. According to the 1950 Census of Population, in the Philadelphia metropolitan area, which includes many outlying areas, population increased from 3,199,637 in 1940 to 3,671,048 in 1950, or an increase of 15 percent. Also, the average number of production workers for the Philadelphia metropolitan area increased by 37 percent from 1939 to 1947; an increase which may be compared with that for all of the 168 standard metropolitan units in the United States—54 percent. See United States Bureau of the Census, **Statistical Abstract of the United States,** 1952, p. 784.

2**Newsweek, op. cit.,** p. 36.

3Philadelphia Housing Association, **Issues,** February-March, 1956, p. 1.

4"Survey of Buying Power," Annual Survey of **Sales Management,** May 10, 1957.

5**Newsweek, op. cit.,** p. 41.

6"Families of the Delaware Valley," a survey of economic and occupational status and activity conducted for **The Philadelphia Inquirer,** and prepared by Alderson & Sessions, Philadelphia, Pennsylvania, 1956, estimated from p. 41.

of families in the thirteen-county area had incomes from $5,000 to $7,499 as compared with about 21 percent for Philadelphia families.[7]

The automobile is another factor affecting the location of retailing activities. Shopping center development in the outlying districts is closely linked to the automobile. There are 69 million cars now as compared with 43 million in 1947, and by 1975 an estimated 100 million cars will be on the roads of America.[8] For example, in the thirteen counties outside Philadelphia, 70 percent own automobiles, while only 55 percent of the Philadelphia families own automobiles.[9] Also about 16 percent of the families in suburban Philadelphia have two automobiles as compared with eight percent of those in Philadelphia.[10]

To summarize, a definite trend of population to the outlying regions of cities is evident, and in these areas family income is higher than in the cities. Both of these facts are very significant to retailers. Shopping centers of all types are being developed or planned in order to cater to the suburban population. Department stores and supermarkets have been the leaders in shopping center development. As a consequence these forces have affected the retail structure of both central districts and the outlying areas of any region.

Before the nature and trends of shopping centers of the nation and Philadelphia are discussed, it is important to analyze the past retail structure of a city.

THE RETAIL STRUCTURE OF PHILADELPHIA

A 1935 classification of retail locations for Philadelphia was developed by Malcolm Proudfoot in a United States Department of Commerce Study, and is listed as follows: central business district, outlying business center, principal business thoroughfare, neighborhood business street, isolated business cluster, village business cluster and isolated roadside business outlet.[11] The central business district was specifically characterized as the point of intersection of all transportation arteries. It is the spot which was most convenient to the greatest number of people.

In a study of the Philadelphia Planning Commission in 1951, the central business district was defined to include blocks between the Delaware and Schuylkill Rivers on the east and west, and Spring Garden and South Streets on the north and south. Key areas noted were City Hall, Rittenhouse Square, Independence and Washington Squares, Franklin Square, and Logan Circle. Blocks with the greatest number of establishments were concentrated near the intersection of Broad and Market Streets. A minor concentration of establishments was located at Rittenhouse Square.

The mode of travel used by shoppers to central business districts indicates accessibility. A study in 1946 showed that 88 percent of shoppers traveled by transit.[12] Eighty percent of shopping trips were made by women, of whom about three-fourths were housewives. The bulk of shoppers arrived before and after the noon hour.

The central shopping district is often referred to as a "100 percent district." Other terminology useful in understanding the structure of the central business district includes "inner core," "inner belt," and "outer belt." The center city department stores and adjacent specialty stores at the junctions of greatest intra-city transportation and pedestrian traffic density and with greatest accessibility, would be the "inner core." The financial, political, recreational, and religious activities nearby would be referred to as the "inner belt." The

[7] **Loc. cit.**
[8] **Ibid.,** p. 37.
[9] "Families of the Delaware Valley," **op. cit.,** estimated from pp. 34-35.
[10] **Ibid.,** estimated from p. 29.
[11] United States Department of Commerce, **Intra-City Business Census for Philadelphia, Pennsylvania,** May, 1937.
[12] Urban Land Institute, **Technical Bulletin No. 24,** "Shopping Habits and Travel Patterns," March, 1955, p. 17.

"inner core" and "belt," then, would contain the center of gravity or control of all activities. The "outer belt" would be the area beyond the "inner core" and "belt." It would contain deterioriated residences and commercial structures and would have generally lower land values than the former.

Total Retail Sales in the Central District

The amount of retail sales in the central district of the city reveals retail trade patterns. In a study of retail trade in Philadelphia in 1935, the central shopping district contained 9.2 percent of the city stores and accounted for 37.4 percent of the retail business.[13] (See Table 2). The general-merchandise group with 71.5 percent, and the apparel group with 63.2 percent were leaders in the central district with 40.0 percent of city sales. The furniture-household group, the restaurant group, and other retail stores accounted for one-third of sales. Drugstores accounted for 25 percent, while food stores were credited with only about 6.0 percent of sales. This study shows, therefore, that the majority of retail trade was not done in the central district. It also shows the pulling power of apparel trade and thus the attraction for female shoppers.

Percent of Retail Trade in Outlying Areas

The outlying retail trade structure, in general, is composed of outlying business centers, forms of "string street" development or business thoroughfares, and clusters of retail stores.[14]

Shopping-goods outlets are predominant in "outlying business centers." Women's and men's apparel, furniture, shoe, and jewelry as well as department stores all are to be found in such centers. Customers are attracted from long distances to these locations.

In 1935, according to the Census Study, outlying centers contained 18.6 percent of all stores and accounted for 19.2 percent of all sales in Philadelphia. The leading sales groups were as follows: furniture-household, 38.6 percent; automotive, 34.8 percent; and apparel, 26.9 percent. String-street store sites were found along streetcar and bus routes which were the cores of residential areas. These thoroughfares carried heavy automobile and pedestrian traffic. Many automobile dealers, furniture stores, and narrow-line shopping stores were found there. Thoroughfares containing 2.8 percent of all stores accounted for 3.3 percent of sales. Food and automotive establishments were dominant and, with the exception of these groups, thoroughfares were of minor importance in the retail distribution of Philadelphia at that time.

Cluster types included community business areas, subcenter sites. These clusters or nucleations varied in character and were somewhat difficult to define. The locus of nucleation was generally at the junction of two string streets. Clusters often appeared in tributaries to the residential area. There were also lower grade nucleations termed, "isolated store clusters" which supplied convenience goods to residents within walking distance. These retail store sites differed by degree in character, size, and convenience.

The community business areas contained 69.4 percent of all stores doing 40.1 percent of sales. Food stores accounted for 69.3 percent of city sales. Automotive, drugstores, lumber, and hardware stores were also dominant. The most important retail trade classification for Philadelphia in 1935, thus, was the community business area.

LAND USE CONCEPTS

Urban land economists and sociologists have contributed to the knowledge of the retailer and the city planner with their analysis of city growth. Future land use patterns can be planned for the welfare of everyone in a region.

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[13] **Intra-City Business Census for Philadelphia, op. cit.**

[14] **Ibid.,** p. 13 and Richard Ratcliff, **Urban Land Economics,** McGraw-Hill Book Company, Inc., New York, 1949, Chapter 13.

TABLE 1

POPULATION, RETAIL SALES OF SELECTED TYPES OF GOODS, AND EFFECTIVE BUYING POWER FOR PHILADELPHIA AND SELECTED SURROUNDING COUNTIES, 1950 AND 1956

County	Population 1950	Population 1956	Families 1950	Families 1956	Net Effective Buying Income 1950	Net Effective Buying Income 1956	Net Effective Buying Income per Family 1950	Net Effective Buying Income per Family 1956	Retail Sales 1950	Retail Sales 1956	Food Store Sales 1950	Rank[1]	Food Store Sales 1956	Rank[1]	General Merchandise Sales 1950	Rank[1]	General Merchandise Sales 1956	Rank[1]	Drug Store Sales 1950	Rank[1]	Drug Store Sales 1956	Rank[1]	House-Furn. Sales 1950	Rank[1]	House-Furn. Sales 1956	Rank[1]
									(in thousands)																	
Phila.	2,164	2,180	610	638	$3,682,770	$4,132,767	$6	$6	$2,209,935	$2,702,511	$514,709	5	$565,237	5	$540,873	3	$587,918	4	$57,151	5	$82,391	6	$109,045	5	$150,727	5
Bucks	127	256	35	75	129,791	474,902	3	6	71,852	253,271	21,624	N	62,120	22	2,709	N	20,582	189	1,370	N	6,608	136	2,372	N	12,472	146
Delaware	398	516	109	146	553,207	1,189,779	5	8	296,813	500,456	96,967	47	138,952	53	22,184	109	62,086	66	12,248	93	17,960	59	12,915	58	19,630	90
Montg.	338	463	92	127	501,583	1,084,433	5	8	303,443	526,568	91,310	50	124,020	63	25,447	94	66,855	62	8,356	N	16,752	68	14,906	N	27,155	N
Chester	146	182	30	47	139,901	333,028	4	7	112,039	199,300	29,267	85	42,766	176	5,278	N	11,733	N	3,162	N	5,614	191	5,593	200	14,745	124
Camden	286	337	80	99	352,489	646,632	4	6	216,904	397,242	65,523	76	99,875	76	18,261	130	36,754	117	4,709	125	9,671	104	15,935	73	23,232	77
Gloucest.	86	109	25	32	94,511	192,054	2	6	47,208	111,811	12,865	N	26,599	N	1,384	N	3,952	N	1,175	N	3,038	N	1,392	N	5,433	N

Source: Sales Management, "Survey of Buying Power," May 10, 1950 and May 10, 1957. [1]Rank - position in the nation. [N]Not listed

TABLE 2

PERCENT OF TOTAL STORES AND TOTAL SALES FALLING IN CENTRAL BUSINESS DISTRICT AND COMMUNITY BUSINESS AREAS, PHILADELPHIA, 1935

Business Groups	Central Business District % of Stores	Central Business District % of Sales	Community Business Areas % of Stores	Community Business Areas % of Sales
All Groups	9.2	37.4	69.4	40.1
Food Stores	2.5	5.7	21.9	69.3
Automotive Group	5.0	9.5	70.5	36.4
Filling Stations	1.8	2.2	85.4	70.5
General Merchandise	4.9	71.5	63.5	21.7
Apparel	22.1	63.2	36.8	9.4
Furniture-Household	13.0	34.9	42.6	22.1
Lumber, Bldg.,Hard.	7.3	15.3	66.9	59.8
Restaurant	14.6	37.4	67.1	41.0
Drugstore	5.7	25.2	77.2	51.0
Other Retail Stores	17.6	37.0	60.5	41.5

Source: Intra-City Business Census Statistics for Philadelphia, Pennsylvania, Bureau of the Census, May, 1937.

TABLE 3

LINKAGE OF RETAILING ACTIVITIES AS SHOWN BY NUMBER AND TYPE OF STORE MADE BY SHOPPERS IN ONE DEPARTMENT STORE

Type of Establishment Visited	Number of Stops	% of Total Stops	% of Total Stops at Others
This Dept. Store	47,592	44.4	----
Other Dept. Store	18,164	17.0	30.5
Specialty Shops	12,452	11.6	20.9
Eating Places	9,410	8.8	15.8
Other and Unclassified	19,504	18.2	32.8
Total Stops	107,122	100.0	100.0

Source: Mitchell and Raskin, op. cit., p. 50

TABLE 4

RATING CHECK LIST FOR SITE APPRAISAL USED IN ANALYZING PHILADELPHIA SHOPPING CENTER SITES[1]

Points on Which Site was Chosen (Condensed)	Excellent	Good	Fair	Poor
Competition: type, sales volume, location	2,3,6	4	1,5,8	7
Traffic flow: pedestrian and automobile counts; percent location of site	2,3,5	1,4, 6,10	8,9	7
Transportation Facilities: access to highways, subways, bridges, etc.	2,3,6,7 8,9,10	1,4,5		
Parking Facilities: size, entrances, convenience, safety	1,2,3,4, 7,9	5	6,8, 10	
Side of Street: judgment on access	1,3,4, 5,6	2,7,8 9,10		
Plant: frontage, light, window and interior designs	1,4,5,8	6,7,9, 10		
Detrimental Site Characteristics: old structures, cemetery, industry, vacant lots	2,6	1,3,4, 5,8,9,10	7	
History of Site:	1,2,3,4, 6,9	5,8,10	7	

Key: Alphabetical List of sites approved--1. Gimbels Cheltenham; 2. Gimbels 69th St.; 3. Wanamakers Jenkintown (proposed); 4. Wanamakers Wynnewood; 5. Lits Northeast; 6. Lits 69th St.; 7. Snellenbergs South Phila.; 8. Snellenbergs Willow Grove; 9. Strawbridge & Clothier; 10. Strawbridge & Clothier Jenkintown.

[1]Appraised by a marketing class, Temple University, Spring, 1957, Kenneth Bluestein, Carmella Calluccio, Maurice Finger, Joel Fleischer, Harvey Glass, Jerry Holstein, Ronald Jess, Sherman Levis, Max Perlmutter, Maurice Sokol, Seymour Spector, John Tainter, Stanley Tatler.

TABLE 5

SHOPPING CENTER CHARACTERISTICS AS ILLUSTRATED BY SOME PHILADELPHIA LOCATIONS

Greater Phila. Shopping Centers	Type of Center	Size of Center	Type of Store	Size of Store (thous. sq. ft.)	No. of Cars
Suburban Square	Regional	277,357 sq.ft. GFA[1]	Dept. Branch	114 GFA	1,007
Abington Center	Community	---	Dept. Branch-- 2 Fashion Stores	---	---
Levittown	Regional	755,000 sq.ft.	3 Branches 1 Fashion Store 2 Supermarkets	200 GFA 65 GFA	5,000
Bala Cynwyd	Regional	260,000 sq.ft. GFA	Fashion Store Supermarket	120 GFA 40 GFA	1,700
Cheltenham	Regional	67 Acres	Dept. Branch	240 GFA	---
Cottman-Castor	Regional	14 Acres	Dept. Branch Supermarket	150 GFA 45 GFA	2,000
Main Line	Regional	16 Acres	Dept. Branch Fashion Store Supermarket	-- -- --	1,200
South.Phila.Plaza	Regional	40 stores	2 Dept.Branches 2 Supermarkets	-- --	2,000
Willow Grove	Regional	-----	Dept. Branch Supermarket	120 GFA 35 GFA	---
Oak Park Center	Neighborhood	-----	2 Supermarkets	--	---

Note: [1]Cars $\frac{X \text{ 400 sq. ft.}}{1000}$ = Square Feet Gross Floor Area

Source: Urban Land Institute, Technical Bulletin, No. 30,"Shopping Centers Re-Studied," May, 1957.

The largest forms of land use at present are residences, vacant areas, and streets. The percentage distribution of the total Philadelphia area in 1950 was as follows: residential, 22 percent; vacant, 27 percent; streets, 18 percent; industry, 10 percent; and commerce, 10 percent.[15] The present and planned utilization of the areas involved is important to the businessman selecting a city in which to operate a retail establishment. There is a degree of space competition which relates to the success with which the retail function is performed.

There are different theories that describe the spatial structure of a community. Land uses are distributed either in 1. concentric zones, 2. sectors, or 3. multiple nuclei.[16]

The proponents of the concentric theory generally describe the surface of street land use of a city. Retail and financial uses are at the core. In the second outside circle are found wholesale trade and light manufacturing, surrounded by low-income family homes. Heavy industry is placed in the next zone. Finally, the outer belts contain higher income family homes extending out into the commuter areas.

The sector theory pertains to the movement of shifting among the various rent areas of a city. Sectors or rent areas radiate from the center of city. Low-rent areas and slums are generally found in the center and adjacent parts of the city. High rent areas are found in a limited number of sectors from which there is a graduation downward in all directions. The pattern of sectors, however, varies among cities according to economic, sociological, and geographic characteristics. Rent areas (economic status) appear to conform to a pattern of sectors rather than concentric zones.

For example, in Philadelphia a mid-city sector known as the Lombard area, a southwest-central area from South Street to Washington Street, and sections of Eastwick are considered as slums and deteriorating sectors.[17] In these areas are an estimated 225,000 Negroes and 163,000 whites. These two sectors account for 18 percent of the city's population. Slums and substandard areas cover an irregular arc of 17 square miles around City Hall. The transformation into the slum category has been occurring for the past 36 years. On the other hand, Rittenhouse Square and Chestnut Hill are examples of some of the high rental sectors.

The concentric circle and sector theories are combined by Channey D. Harris and Edward L. Ullman to explain the arrangement of land use in the multiple nuclei theory.

> In many cities the land-use pattern is built, not around a single center, but around several discrete nuclei. In some cities these nuclei have existed from the very origins of the city; in others they have developed as the growth of the city stimulated migration and specialization. The initial nucleus of the city may be the retail district in a central-place city, the park or rail facilities in a break-of-bulk; or the factory, mine, or beach in a specialized-function city.
>
> The rise of separate nuclei and differentiated districts reflects a combination of the following four factors:
>
> 1. certain activities require specialized facilities . . . .
> 2. certain like activities group together because they profit from cohesion . . . .
> 3. certain unlike activities are detrimental to each other . . . .
> 4. certain activities are unable to afford the high rents of the most desirable sites. The arrangement of the nuclei differ from city to city. The larger the city, the more numerous and specialized are the nuclei.[18]

Urban land economists present a penetrating analysis of city growth. As mentioned by Harris and Ullman, certain

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[15]Ernest Fisher and Robert Fisher, **Urban Real Estate**, Henry Holt and Company, New York, 1954, p. 308.

[16]**Ibid**, pp. 309-311.

[17]"Trend to Suburbs Invites Decay in City," **Philadelphia Inquirer**, December 12, 1055, p. 3.

[18]Fisher and Fisher, **op. cit.**, pp. 311-312.

Total Stops 107,122 100.0 100.0
Source: Mitchell and Hopkins, op. cit., p. 50

Edgar M. Hoover and Raymond Vernon, Anatomy of a Metropolis, Harvard University Press, Cambridge, 1959, p. 50

Roland L. Chaplin, Ronald Jess, Sherman Levin, Max Perlmutter, Maurice Sokol, Seymour Spector, John Tainter, Stanley Thaler...

activities require specialized facilities. This would explain, in part, the grouping of the wholesale produce markets at Dock Street or at the proposed Food Distribution Center in South Philadelphia. The grouping of department stores on Market Street in Philadelphia illustrates the fact that like activities group together because they profit from cohesion. The downtown department stores afford comparison by shoppers, without which department store retailing activities would likely decline. The jewelry market at Sansom Street also illustrates the prosperous clustering of like activities.

The concentric zone, sector, and multiple-nuclei descriptions of land use fail to consider uses of space above and below ground. Fisher notes that activities which occur above the street level are important in the study of traffic or the analysis of gradual changes in the location of these activities. It is important, then, to define "land use," which he does, as the activities customarily engaged in by an establishment.[19] Growth and deterioration can be compared with changes in activities.

Activities and Land Use

The structural change in activities of the central district of Philadelphia is evidenced by an index of the rate of net growth of establishments of various types. The ratio between total number of establishments in 1906 and 1949 is equal to an index of 1.35. The following figures show how some activities have shifted during that time.[20] Construction, .83; manufacturing, 1.12; retailing, 1.16; wholesaling, 1.24; business service, 1.45; and consumer services, 1.58. Other statistical data in the foregoing study for the period show that goods-handling wholesaling establishments increased from 1,351 to 2,570 or by 90 percent.

Changes in the number and type of establishments show the movement pattern in central city. For the Philadelphia Central District, study of survival rates among nonresidential establishments during 1906 to 1949 for a sample of 39 blocks shows that only 23 percent of 5,038 establishments were located in the central district in 1906. By 1949, only 31 percent were so located.[21]

Retailer Linkages

A definite linkage exists among department stores in the central shopping district. For example, in a survey of shoppers in Philadelphia it was determined that of 55 percent of all remaining stops after leaving a department store, 31 percent were made at other department stores and 21 percent were made at specialty stores. As shown in Table 3, this is a statistical verification that buying habits of consumers are an important linkage factor in the retail structure of downtown shopping areas.

The type of trip is also important to retailing activities. In an interview survey in the spring of 1950, home-to-home and work-to-work trips were recorded from respondents shopping at a department store.[22] Figures from this survey for home-to-home and work-to-work trips, respectively, are 57.0 and 21.0 percent of total trips; average number of stops, 2.5 and 2.0 percent; percent of trips having this department store as the sole establishment stop, 25.1 percent and 39.5 percent. This survey shows that shoppers compare the merchandise offerings of other department stores. Also, more people on a work-to-work type of trip had a given department store as a sale destination as compared with those on the home-to-home trip. They are not subject to impulse buying as are those on the home-to-home trip.

In addition to being linked by the buying habits of consumers, retailers are also linked from a profit point of view to the nature and stability of total in-

[19] Ibid., p. 313.

[20] Robert Mitchell and Chester Rapkin, **Urban Traffic—A Function of Land Use**, Columbia University Press, New York, 1954, p. 123.

[21] Ibid., p. 124.

[22] Ibid., p. 49.

come sources of a region. It is necessary, therefore, to consider the economic base of a region in which retailers operate.

THE ECONOMIC BASE OF A REGION

There is an economic interrelationship between a region and a city and a site within a city. These areas are, in turn, related to the economy of the nation. Each area, however, must be analyzed in terms of its own economic welfare as patterns of stability, growth, and stagnation vary among areas. There is also a degree of competition between areas with respect to income sources. Income sources are important in that population tends to flow to the area of greatest economic opportunity.

With respect to economic growth, the nature, volume, and stability of income sources of areas must be studied. The analyst should develop data concerning each of the following: 1. Comparisons of area income with gross national product; 2. Comparisons of annual average wages among areas; 3. The ratio of primary to secondary employment; 4. Amounts of goods exported to other areas; 5. Transportation facilities and costs; 6. Zoning plans for future industrial land areas; 7. Proximity to markets and natural resources; 8. Data on entry, exit, and diversification of industry; 9. Population and housing trends; and, 10. Entertainment and recreation facilities.

Market Analysis of Retailing Sites

Once the economic base of the region has been analyzed, it is then necessary to appraise the market areas within the region. A market consists of people and income and the buying habits and motives behind their consumption patterns. Thus, a market analysis must include a study of the nature, distribution, and character of income and the characteristics of population within present and potential trading areas of a site. Trading areas vary with regard to their economic and sociological bases. A coextension of the latter statement, then, would be that locations within a trading area also are subject to forces that give it an individual character. Each site must be thoroughly analyzed. No two locations are identical. Some of the important factors are noted below.

Characteristics of Population. What is the trend in total population? What are the changes by age, sex, and race? What is the family structure pattern? What are the present and likely future characteristics of population in the trading area?

Income Analysis. What are the sources of incomes? What is the average hourly earnings trend? Are there plans for future industrial expansion? Is there diversification of industry? What is the percent of nonmanufacturing employment? What is the per capita and per family income level? What are the trends in home ownership, rentals, and real estate valuations in the area?

Buying Habits-Merchandise Selection. What is the relationship between buying behavior and the classes of consumer goods (downtown and suburban areas)? What is the origin, destination, and time pattern of consumers? What is their attitude toward parking? How many are charge account customers?

Accessibility-Availability. Is the site within ten to thirty minutes of consumers? What is the trend in the number of automobiles (and the lady driver)? Can parking facilities accommodate future expansion? What is the nature and efficiency of public transportation facilities? What are the present and future industrial zoning patterns? What is the inventory of existing structure and vacant land? Is the site at the "hub" of the traffic arteries?

Competition: Present and Future. What are the number, type, and size of stores in the trading area? Does the market potential study show a need for additional stores? What is the sales volume of comparable stores located in

comparable trading areas? Have all ratios or measures such as, sales per square foot, estimated volume, etc. been developed and analyzed?

Parking and Traffic. What is the ratio of gross floor area of the store interior to parking area? Does the ratio compare with that for a successful, comparable site? Is parking space sufficient for future expansion? Can traffic enter the parking area from more than one direction? How often are traffic and pedestrian counts taken?

Many of the foregoing factors are demonstrated by application to a number of Philadelphia sites in Table 4.

Retail Gravitation

An important part of the market analysis pertains to the attraction of retail trade to one shopping area from other areas. The law of retail gravitation points out that the largest city will attract trade in proportion to its size. This law, or some variation of it, is used by many shopping center analysts. William J. Reilly has stated it as follows:

> Two cities attract retail trade from an intermediate city or town in the vicinity of the breaking point, approximately in direct proportion to the population of the two cities and in inverse proportion to the square of the distances (via the most direct improved automobile highway) from these two cities to the intermediate town.[23]

Boundaries for trade areas, particularly for fashion goods, can be stated. Time, place, and possession utilities reflect distance. Another measure of attraction is the sales of fashion goods or square feet of space devoted to fashion goods by retailers.[24]

Other Retail Gravitation Forces

It is difficult to weigh the importance of population size and highway travel distance in the complex determination of retail trade pulling power. There are many spatial variables that compete for the attention of the consumer. Social, cultural entertainment, recreation, safety, physical environment, transportation, merchandising promotions, and buying habits are some generalized factors that must be considered.[25]

SHOPPING CENTERS

The present shopping centers are the result of the retailing investigations in the suburbs in the late 1920s by Sears Roebuck. The dominance of the automobile as a means of transportation for the increasing population in outlying areas was of great importance in the suburban store plans of that company. It is of equal importance today. Accessibility by automobile is a vital consideration in the site selection program of this type of organization. Also, since shopping centers are planned on vacant land areas, more attractive and functional sites can be developed. The plans for downtown shopping areas, on the other hand, are largely limited to existing establishments as previously discussed in the nature of urban land use.

Credit for locating in the suburbs should also be given to the Strawbridge and Clothier department store of Philadelphia. This was an early branch link between a major department store and people in the suburbs. The establishment of a branch in Ardmore, Montgomery County, Pennsylvania, in 1930, is considered as one of the first department store-branch operations in the nation. At that time merchandise selection at the branch was limited. Today the Ardmore

[23]William J. Reilly, **The Law of Retail Gravitation**, Pilsbury Publishers, Inc., Second Edition, New York, 1953, p. 9.

[24]Curtis Publishing Company, **Market Areas for Shopping Lines**, 1947.

[25]The geographic surroundings and knowledge of future competition, for example, can be important factors in site selection. A site at Westbury, Long Island, analyzed in 1952, illustrates the importance of these forces. Adjacent to the site for a number of miles appeared the elevated land embankments of the tracks of the Long Island Railroad. There was also a large cemetery close to the site. Another unfavorable factor of importance was the knowledge that a regional shopping center would likely be constructed at Roosevelt Field near Westbury. Factors of this nature cannot be appraised completely in a law or formula pertaining to the pull of retail trade.

Shopping Center is considered as a fashion center which caters to the higher income customer.

Shopping centers, especially the large regional types, began to develop after World War II when suburban population began to increase sharply. National prosperity, a backlog of consumer demand, and the planning of retailers and government officials aided the growth of these shopping centers. The Korean War, however, slowed their construction. Like the post-World War II period, pent-up consumer demand and intentions were released after the Korean War. Then the real growth of shopping centers took place. The peak year of growth to the present for regional shopping centers is 1956. Intentions to build new shopping centers, however, are strong. Actual construction and plans for all types of shopping centers indicate that two thousand additional units will be in operation in the near future.[26] No matter how important downtown shopping may continue to be, the suburban shopping centers are a major factor in retailing today.

Types of Shopping Centers

Planned shopping centers are generally classified as neighborhood, community, and regional centers.[27]

Convenience goods stores predominate in **neighborhood shopping centers.** The parking ratio should be about eight cars per thousand square feet gross floor area. At present, there are generally four to twenty tenants in such centers. Most of them contain less than 40,000 square feet of gross floor area.

The **community center** is generally characterized by shopping goods. Many convenience goods can also be found in the merchandise selections of consumers. The parking ratio averages 8.17 cars per thousand square feet of gross floor area. Most centers have from twenty to thirty stores. The gross floor area of most centers ranges from 75,000 to 150,000 square feet.

The **regional shopping center** is nearly synonomous with the so-called "one-stop shopping area." Usually it will contain a branch department store and a general range of from 35 to 60 other stores. The parking ratio averages 7.33 cars per thousand feet of gross floor area. The majority of all shoppers in such centers generally reside within thirty minutes by automobile travel. Most have over 400,000 square feet of gross floor area. The trading area may extend twenty miles and should contain at least 100,000 families.

There are only two regional shopping centers in the Greater Philadelphia Area. Compared with other regions with similar economic bases, more shopping centers can be built. Also, the gross floor area of stores and the parking ratio of shopping centers in Greater Philadelphia is below the national average. Table 5 illustrates the characteristics of shopping centers within the Greater Philadelphia area.

Are There Too Many Shopping Centers?

There is some concern about the possible saturation point in shopping center development in the nation. In mid-1956 there were more than two thousand shopping centers of all kinds in operation. There are more to be built. Including present construction and plans for additional centers, another two thousand are to be developed.[28]

A study of shopping centers in Long Island, New York, indicates that in that area the saturation point has not yet been reached. There are four large regional shopping centers — Roosevelt Field (Manhassett), Miracle Mile, Hicksville, and Valley Stream, all of which contain one or more department store branch, supermarkets, and variety stores,

[26]Paul Smith, **Shopping Centers,** National Retail Dry Goods Association, New York, 1956, p. 18.

[27]Data for shopping centers are developed from Urban Land Institute, **Technical Bulletin, No. 30,** May, 1957.

[28]"Too Many Shopping Centers?" **Business Week,** November 17, 1956, pp. 136-138.

and a range of the other store types generally found in regional shopping centers.

Investigation of intentions and profits of department stores with regard to branch operations is quite favorable. The Northland Shopping Center in Detroit shows a sales volume of $100 million of which 50 percent was accounted for by the Hudson Store.[29]

More neighborhood and community shopping centers will be developed as population moves to interurban areas. The supermarket will be an influential force in those centers. Regional shopping centers, however, may be somewhat limited. William Puckett of Allied Stores claims that there are only 75 market areas with populations of 350,000 left in the nation.

Are Supermarkets Necessary for Shopping Center Profit?

Experiences and intentions are perhaps the best way to appraise the relationship of supermarkets to shopping center success. Linked to the development of shopping centers is the expansion program of the supermarket. About half of the supermarkets opened in 1955 were in shopping centers.[30] Supermarket executives are somewhat concerned, however, with the drop in productivity in sales per square foot of the newer stores as compared with the older stores.

Linked to the expansion of supermarkets is the increase in population, income, and food expenditures. It is estimated that supermarkets account for 60 percent of total retail grocery sales.[31] Supermarkets, therefore, will take a good share of consumer expenditures for food if present buying patterns are maintained in the future.

With respect to future consumer expenditures for food, Arno H. Johnson has made a projection which indicates that consumers will spend 25 percent of their 1955 income for food items from 1955 to 1960 and 45 percent of their 1955 income from 1960 to 1965 in terms of 1955 prices. Thus, expenditures will run at an annual rate of $65.5 billion in 1955, to $83 billion in 1960, and $96 billion by 1965. It is assumed that 27.5 percent of future personal income will be spent for food.[32]

On this basis, supermarkets account for a good share of the consumers' expenditures and are following the population to the suburbs. As seen in Table 5, most regional shopping centers in Greater Philadelphia contain one or more supermarkets. The type of shopper at the supermarket is also important. In 1956, about fifty-five percent of the shoppers in husband-and-wife families were housewives and about thirty percent were husband and wife together.[33]

Consumer Goods Classifications and the Shopping Center Developer

From a marketing viewpoint, an analysis of the buying habits and the motives of people in an area is essential to the success of retailers at a given location. Professor Copeland's classification of consumer's goods is still important even though some authorities tend to minimize its importance.[34] His definitions of the classes of consumer goods still constitute a body of knowl-

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[29] **Ibid.,** p. 138. In the Greater Philadelphia area, John Wanamaker's will locate a branch store in Jenkintown in the near future; Gimbels has just opened a branch at 69th Street; Strawbridge and Clothier is locating a branch at Cherry Hill, New Jersey, and Lit Brothers is planning to open a branch in Morrisville, Pennsylvania.

[30] "Supermarkets Face the Future." **Harvard Business Review,** March-April, 1957, p. 128.

[31] **Loc. cit.,** p. 128.

[32] **Ibid.,** pp. 128-129. Population, consumer expenditures for food, and per capita expenditures for food were projected as follows:

Year	Consumer Expenditures for Food (billions)	Population (millions)	Per Capita Expenditures for Food
1955	$66.5	$165	$403
1960	83.0	179	464
1965	96.0	193	497

[33] "The Families of the Delaware Valley." **Philadelphia Inquirer Study, op. cit.,** estimated from p. 55.

[34] Melvin T. Copeland, **Principles of Merchandising,** New York, McGraw-Hill Book Company, Inc., New York, 1927, p. 13.

edge on which many location and merchandising decisions are based.[35]

Another authority in retailing claims that developments over the last two decades have decreased the importance of the knowledge of consumer goods in choosing a site for a retail store.[36] Some of the reasons for this opinion pertain to the increase in good roads, increased use of the automobile, urban decentralization, and changes in the shopping habits of women.

Knowledge of the consumer goods classification, however, is important to shopping center developers. The regional shopping center, as noted earlier, is composed of the types of stores found in downtown shopping districts. Knowledge of consumer goods is of value in selecting a site in the suburbs. This type of shopping center, because it is developed as a unit, also has the advantage of better planning as compared with the older, downtown shopping district.

The shopping center, then, is basically a recentralization of retailing activities in a smaller core, which has been caused by the movement of people to the suburbs. An outstanding example of the reclustering of the downtown retail structure in the suburbs can be found in Long Island, New York, and in Levittown, Pennsylvania.[37] Department store branches, specialty department stores, specialty stores, variety stores, women's and men's wear shops, supermarkets, and entertainment establishments are found in such regional shopping centers.

The buying habits and motives that lead the consumer to the central business district apply with equal importance to the regional shopping center in suburbia. This suburban center is also a focal point for social, recreational, and cultural activities of the community.[38] The community center, characteristic of the shopping center, attracts people on a relatively frequent basis and keeps them there for longer periods of time.

How Does the Shopping Center Affect the Downtown Department Stores?

Before citing some conclusions, it is necessary to consider the retailing activities of the downtown department store and their branches in the suburbs. Some of the reasons people dislike central business districts are: lack of parking facilities, traffic congestion, blighted residential and commercial structures, and the long period of time involved in the home-to-home trip. In a survey conducted in Philadelphia in 1948, respondents cited the following general reasons for not shopping downtown: "lack of

[35]Consumer goods are classified as shopping goods, convenience goods, and specialty goods. Shopping goods are those goods in which consumers compare style, quality, or price before arriving at a buying decision. Women's apparel in general is considered to be of high-unit value. The lady shopper or ladies' shopping groups, then, may begin a shopping trip at the John Wanamaker department store. From this store, the lady shopper may travel to Snellenburgs, Gimbels, Lits, and Strawbridge and Clothiers—comparing price, quality, and style of clothing, jewelry, or furniture. After arriving at a buying decision as a result of this comparison, the lady may return to a previous department store to make a purchase. Other factors appealing to the lady shopper are the entertainment and cultural facilities near department stores. The nature of buying habits is shown in a previous section pertaining to retailer linkages.

Convenience goods are usually standardized items of low-unit value purchased at frequent intervals. Most food and drug items characterize this classification. The term "convenience" is self-explanatory. These goods should be within walking distance or ten minutes by automobile travel. The outlying community business areas are dominated by convenience goods outlets, such as grocery-drug stores. The most important patronage motive in the purchase of convenience goods is convenient location.

Specialty goods are those products for which the consumer insists upon and is willing to make a special effort to buy. Such purchases are relatively infrequent. There is not, therefore, the need for widespread distribution of specialty goods compared with convenience goods. Also, the need for locating in central shopping areas is not as great as it is for shopping goods. Specialty stores, therefore, are generally located a short distance from the downtown department stores. These stores, for example, can be found along Chestnut Street in Philadelphia and Fifth Avenue in New York City.

[36]Charles Duncan and Charles Phillips, **Retailing.** Homewood, Illinois: Richard D. Irwin, Inc., 1953, p. 131.

[37]Eugene Kelley, **Shopping Centers,** The Eno Foundation for Highway Traffic Control, Connecticut, 1956, p. 36.

[38]Victor Gruen, "Planned Shopping Centers," **Dun's Review,** May, 1953, p. 117.

time," "don't like downtown," and "high prices."[39] Reasons for shopping at a downtown department store, on the other hand, were centered around the nature, quality, and variety of goods offered. This survey also pointed out that if a shopper had a favorable attitude toward the store, there would be a tendency to increase purchases by those with charge accounts. The Alderson and Sessions, **Philadelphia ABC Trading Area Survey** in 1956, showed that Lit Brothers has more charge accounts of Philadelphia families, while Strawbridge and Clothier leads in charge accounts for families in the outlying thirteen counties.

The shopping center customer is also the downtown store customer. The housewife clad in peddle pushers when buying in an outlying shopping center, however, dresses more appropriately when shopping downtown. Knowledge of such habits of women are important to store owners. A fashion store in the suburbs or the downtown area, for example, will not as a rule locate next to a supermarket.

The influence of the lady shopper has been cited. Again, a survey in 1956 confirms the power of the female purchaser. About sixty-eight percent of the women interviewed in Philadelphia families cited center city as the location of their last purchase of women's clothing.[40] Also, apparel and things for the house account for a large percent of sales of center city department stores. Of the total sales of women's clothing, an estimated sixty percent is accounted for by these stores.[41] As noted in the **Intra-City Business Census Survey in Philadelphia** for 1935, 63.2 percent of apparel (all types) sales were made in the central district.

There are, however, decided variations in the shopping patterns of families in Philadelphia and the surrounding thirteen counties. These families divide their shopping trips between the outlying shopping centers and the downtown district. There appears to be a concentration of shopping activities at Camden, Wilmington, and 69th Street for families in the thirteen-county area, while Castor-Cottman, Cheltenham, and Roosevelt Boulevard seem to be the leading centers for families in Philadelphia. The data also show that most families in these areas will visit the center city shopping area with equal frequency.

It is difficult to determine whether the branch store operation has adversely affected sales of the downtown store. Both have shown increases in sales. The branch store will have a higher sales ratio in the children's, women's, and men's sportswear, and summer departments, while having a lower ratio than the downtown store in house furnishings, high-price, ready-to-wear goods, books, and cosmetic departments. The percentage of branch store to downtown store sales was about thirty-three percent in 1955. Also many branch stores contributed over fifty percent of total company operating profit.[42]

Indications are, then, that the sales volume of department store branches will continue to increase. In this respect many executives of department stores have failed to consider future growth when planning a branch store. This leads to inadequate gross floor and gross parking area for the branch store as indicated in Table 5. The variety of merchandise to be offered also will be limited and therefore will increase costly interstore transfers. These are some of the factors that call for better planning. Department stores and other types of retail organizations, thus, should have capable market research departments.

As previously mentioned, there are

[39]Myron Heidingsfield, "Why People Shop in Downtown Department Stores," **Journal of Marketing**, April, 1949, p. 510.

[40]Families of the Delaware Valley," **op. cit.**, estimates from p. 78.

[41]**Ibid.**, pp. 76-77.

[42]Paul Smith, **op. cit.**, pp. 170-171, 190. The author also quotes Malcolm P. McNair who concludes with regard to the branch stores: (1) the establishment of branches yields greater growth of sales volume as compared with stores doing their business under one roof; and (2) the proportion of the branch business will continue to increase.

many reasons why people do not like the central business districts of cities. The downtown stores, however, can increase their sales volume by aiding in revitalizing or redeveloping the inner core of the city. The central business districts of many cities need rebuilding of the blighted structures, development of superhighways, improvement of recreational and entertainment facilities, and expansion of parking areas. The executives of downtown stores might well take a more active interest in city planning.[43]

CONCLUDING OBSERVATIONS

Population

1. There has been a long-term increase in suburban population. As the trend increases more communities will be developed in areas beyond the city and its present suburbs.

2. The purchasing power (per family income) is higher for suburban families than for city dwellers and they also have greater equities in their properties.

Shopping Centers

1. The department store branch and the supermarket are an integral part of regional shopping centers.

2. The supermarket appears to be essential to the success of the community and neighborhood centers.

3. The shopping center is and will continue to be a major factor in changes in the pattern of retailing activities.

Department Stores

1. The department store is confronted with a retailing dilemma. It must help in promoting the revitalization of the old downtown areas and in establishing new branches to cater to changing habits of the increasing population in outlying areas.

2. General merchandise and apparel continue to be leading sales departments for department stores and other retail establishments in the central business district.

3. Department store branches have made and are likely to continue to make increasing contributions to department store sales and profits. Thus, it appears that more branches will be located in outlying areas.

4. Branches seem to sell a higher proportion of ladies' and men's sportswear, children's goods, and summer goods.

The Supermarket

1. The supermarket now accounts for about sixty percent of grocery sales. Thus, as new markets are developed in outlying areas, the supermarket will take an increasing share of the grocery business.

2. Some concern has been expressed with regard to a drop in productivity in sales per square foot of newer stores.

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[43] With respect to city planning and redevelopment, Philadelphia ranks among the leading cities in the nation. The development of Penn Center and the planned improvemets of the Academy of Music in the business district are and will be definite attractions. Other favorable developments are the construction of the Walt Whitman Bridge, the planned Food Distribution Center, the planned Eastwick housing development, the rezoning of areas for industrial use, the planned superhighways (such as the Schuylkill Expressway), and the possibility of a monorail train to accommodate commuters.

Management in the Electronic Age

by F. F. MIDDLESWART*

Ed. Note: The following papers covering the impact which the electronic age is having on management, were presented as a part of the Ninth Regional Conference of the Philadelphia Student Chapters of the Society for the Advancement of Management at Temple University. The papers have been cut somewhat to fit space limitations.

THOSE of us who are actively interested in the subject of "Management," whether we are students in colleges and universities or actually have the responsibility for management, are much aware of the attention being given to the relatively new and exceptionally popular body of techniques called operations research. We read about the operations research approach to management problems and are told that it can aid management in making decisions, improving planning, refining forecasting, and performing many other management functions more effectively. Also, the literature is full of current uses and glowing predictions of the powers of electronics to assist management in doing a better job. However, if one studies the actual and proposed applications closely, he soon learns that, throughout them all, the manager himself plays a most important role. None of these devices, tools, or techniques in any sense replaces management; they are simply aids to the manager's effectiveness.

With this in mind, let us turn our attention to management itself set against the background of electronics and operations research. We will not consider the techniques or equipment of tomorrow's management world, but rather will take a look at the kinds of things the manager will have to deal with and discuss some of his personal qualifications.

All are familiar with the glowing predictions of our economists for a large increase in gross national product during the next decade. However, one wonders how many have considered these predictions in the light of the recently publicized figures which show that there is to be essentially no increase in the number of workers in the 18-45 age group during this period, while at the same time the number of people under 18 and over 64 will increase markedly. If our gross national product is to double as predicted, the labor figures therefore imply that our productivity must nearly double. Since very recent figures show that productivity has increased by approximately 30 percent to 35 percent in the past decade, one can only conclude that management must bear the brunt of the load in devising means of upping productivity so that the forecasted growth in gross national product may be realized.

MANAGEMENT FUNCTIONS

If such attention is to be focused on management, we would do well first to consider its function.

For the purpose of this discussion, a business may be defined as an organization to produce a product at a profit, or to provide a service at optimum cost. Furthermore, the management function, whether at the foreman's or clerical supervisor's level or at the corporation president's level, consists of three distinct elements; namely, administrative, planning, and control. In this paper the terms administrator, planner, and controller are used to designate those individuals whose primary responsibility is to carry out the duties of one or more of the respective elements of management. In some instances all three of

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these elements may be the responsibility of one person who must perform all of them, while in some organizations, especially some of the larger ones, each of these elements is the responsibility of a distinct group, including even the administrative element. In between these extremes, one can find examples in which various mixtures of the elements are distributed among individuals or groups or both. Studies of these functions show that it is not uncommon for them to become indistinct in growing organizations unless particular attention is given to defining them at each stage of growth, at each change in organization, or with each new appointment of key personnel. When the responsibility for these elements becomes indistinct, there is often confusion and most certainly a lowering of management effectiveness.

Administrative Element

The administrative element of the management function may be considered first. It is absolutely imperative that the person or group exercising administrative powers has both the responsibility and authority to establish the organization and policy to permit performance criteria to operate and objectives to be met. By "performance criteria" is meant a set of predetermined attainable standards of performance having well defined lower and upper control limits. Performance within the bounds of the control limits is considered satisfactory; performance outside the limits requires immediate management attention. This means that passive management is out. There can be no "hope-so" type of administration. Management must dynamically establish realistic goals and objectives and then take the necessary positive steps to provide the proper environment for meeting them. Those responsible for the administrative element must establish criteria for assessing performance and authorize revisions of these criteria to adapt them to changing conditions. The administrator must make decisions promptly for all items that are not routinely controlled by the established criteria; this requires him particularly to assess the effect of factors extraneous to his area of control and to take appropriate action. It is in this area that some of the operations research techniques are most helpful.

Planning Element

The second element of the management function which may be considered is the planning element. This includes more than simply making plans for the future. Those involved in planning have responsibility for several activities. Of primary importance is a continual evaluation of the adequacy of the performance criteria which have been established by the administrator. It has been rather common practice to establish so-called standards which represent, in most instances, a sort of average performance for the period immediately prior to the establishment of the standard. From that time on, measurement is made against such a standard and performance is judged thereby. If one thinks about this for a moment, one realizes that measuring the output of an organization against such static standards may not really measure the performance of the organization, but rather its conformity to a previous average performance, which may or may not be adequate for today's business conditions.

Provisions for proposing revisions to existing performance criteria to keep them current must be a part of the planning element. As a by-product of this evaluation of the adequacy of existing performance criteria, the planner has the responsibility for proposing new criteria applicable to the changing situation. This forces the planner to give attention to the future; for if performance criteria are to be dynamic, they must be based on past performance with due consideration for what is most probably to be required as adequate future performance. This aspect of planning is greatly enhanced by the ability of electronic data processing equipment to digest and make available

almost instantly vast amounts of data including information concerning what happened but a few minutes, or at most, a few hours previously.

Another aspect of the planning element is the evaluation and reporting to the administrator of trends in markets, prices, policies, and general economic conditions which will affect the business. Here conclusions must be based on a discreet analysis of the past, coupled with a prescient understanding of the future. These evaluations must include the analysis of pertinent data arising from outside the company. There are many sources of such data. The principal problem confronting the planner is to select from the tremendous volume of available data those that are related to factors which will affect his business. This will vary from company to company. Those data that may be of real significance to Company "A" in doing an adequate planning job may be misleading if applied to Company "B." Conversely, that which can lead Company "B" to make decisions insuring the success of its business, might conceivably lead Company "A" to decisions that would insure its downfall. Thus, the planner must be characterized by prescience.

One further aspect of planning is a constant evaluation of the objectives and goals for the business which the administrator has established. Such goals and objectives are a function of time. Changing economic conditions or international relations can make objectives which are ideal today quite unrealistic tomorrow; or, on the other hand, changing business conditions can make today's hard-to-attain, yet realistic, objectives quite inadequate when considered in the light of tomorrow's potential for a given business. To be useful, goals and objectives must be kept up to date.

Control Element

The third phase of the management function is the control element. Several areas of responsibility for the successful conduct of the business are inherent in this element. Perhaps the most important is the responsibility to measure day-to-day accomplishment against the criteria established by the administrative element for measuring performance, and to report the results to both the planning and the administrative parts of the organization. Historical records of performance must be maintained in such a way that the planners will have adequate and easily accessible data on which to base their work.

In establishing the responsibilities for control, the administrator may delegate to the control organization the authority to make adjustments to the system within prescribed limits in order to keep it within control with respect to established criteria. This does not relieve the administrator of responsibility for making administrative decisions; it simply is a device to permit economic handling of the more routine administrative duties.

One further responsibility of the control element is to process legal and historical documents required for accounting and tax purposes. These documents, though legally required, do not serve as a dynamic part of the management function. They are a by-product of the data flow through the system which constitutes what may be called "the management data loop."

"MANAGEMENT DATA LOOP" SYSTEM

Just what is meant by "the management data loop?" This is a concept of the management function which is borrowed from our chemical engineering colleagues who are continually discussing closed loop systems for process control. A closed loop system contains a sufficient number and variety of devices to permit it essentially to control itself. It does this by gathering data at various points in the system, feeding these data into data reduction devices which measure the current activity against prescribed and present standards, and then

it automatically institutes the necessary action to exercise control over the process. This control may involve resetting of values or other control devices, as well as recomputing set points to take optimum advantage of changing conditions. Such a system has within it the three elements of management. It has the control function, which continuously gathers information dealing with performance and measures this against the pre-established performance criteria. It has the planning function which tests the adequacy of the criteria for maintaining control and either recomputes and sets up new criteria or informs the human operator that things have gotten beyond its capacity to make such adjustments. However, in such systems the administrative function still is the responsibility of the human beings who establish the process specifications and limits before they turn it over to the devices in the process loop.

The business management function may be visualized as analogous to this closed loop concept of process control. In both instances, the human judgment factor must be retained. Neither a chemical process nor a business process can operate long without the intervention of people. Before developing this further some of the data handling that is required to activate this concept of management should be considered.

Data Required

To make possible the closed loop system of management, one must have adequate current data and facilities for its rapid analysis and accessible storage. Investigations have shown that most organizations have stored away considerable useful information that is not available for ready reference or use because of the difficulty in retrieving it, even if those who might use it effectively know that it is there. A new science known as documentation is rapidly gaining standing in our business world, and it is furnishing valuable new tools to aid in the management function. Through the use of documentation techniques, valuable information can be stored economically in such a manner that it can be retrieved conveniently and used when required to assist the planning, administrative, and control elements of the management function. Speed of gathering and analyzing accurate data is of utmost importance in these new management concepts.

Mathematical models and statistical methods are beginning to play very important roles in this field. However, to take full advantage of these techniques, one must use electronic data processing equipment. The problem of adequate codes then becomes tremendously significant since we can no longer depend on words or sentences to describe classes of events sufficiently precise for use in the data handling systems of the future. We have been carrying on a code research project for some months and have found that this is an area of knowledge which can be explored considerably before we will have done much more than just scratch the surface. To make efficient use of the new electronic equipment as an aid to the management function, one must be prepared to tie together all of these techniques, most of which are foreign to the art of management as it has been practiced up until now.

Requirements for Management Men

So much for the tools and techniques of the management function in this new age. What requirements do all of these concepts put on the management man himself? To fulfill the responsibility for the administrative element, the manager must possess the ability to establish necessary and sufficient criteria by which to assess continuously the performance of his organization. I want to emphasize the words "necessary" and "sufficient." Those who have had mathematical training will recall that this is a frequently recurring phrase in proving mathematical theorems. For example,

the mathematician says that if thus and so would be true, it is necessary and sufficient that a specific set of conditions exist. Such a set of conditions contains all the elements necessary, but only those conditions required to insure that the given statement is true or that a given result will follow. In proving a theorem, it is often easy to establish necessary conditions or sufficient conditions, but to get just that set of conditions which is both necessary and sufficient often requires considerable mental strain. That which is true in mathematics is also true in management. We cannot afford unnecessary conditions, yet we dare not risk trying to operate with insufficient conditions. Some mental strain will be required of the administrator in establishing the necessary and sufficient criteria for his business control.

Another requirement of the management man of the future is that he have an understanding and some knowledge of statistical methodology. By this is not meant that he must be a highly proficient, practicing, theoretical statistician. However, he must have a basic understanding of the power and limitations of the statistical method and sufficient confidence in its validity to use it effectively. This understanding will be required in all three elements of the management function. Somewhere in the planning organization there will have to be one or more skilled professional statisticians who will serve to handle the vast amount of data required to fulfill the responsibilities of the planning element.

A third characteristic of the manager of the future will be some understanding of and confidence in the use of mathematical models for describing business functions. However, this is not to imply that all business will one day be run by formulas. There are too many variables that have high order interactions which we at the moment are unable to express mathematically. These conditions require constant application of human judgment, although many of the basic controls can be expressed as mathematical models. An analogy would be that the mathematical model is the skeleton which supports the body of a business system, the flesh and blood of which is furnished by human judgment.

Another aspect of management which is rapidly coming to the fore is the so-called "management by exception." With sufficient understanding of and confidence in the use of statistical methods and mathematical models, the manager of the future will be able to handle the routine aspects of his management function by the exception principle. Preestablished criteria will serve to define the limits of normal operation so that the manager will be required to give attention only to those items which do not fall within the prescribed normal routine. As a consequence, he will be freed from the perusal of vast amounts of routine, noninformative data which now floods his desk and will have time to devote to the portions of the business requiring his concentrated attention and mature judgment.

Since more and more data will be available to management to form a basis for decisions, the manager of tomorrow must develop an ability to relate to his business a variety of data coming from many sources and to assess the significance of those data on his operations. It is in this area of assessing the significance of reported data that "the men will be separated from the boys" in the management function. An undue amount of attention given to nonsignificant data, or a failure to recognize the significance of a small change in conditions, or of apparently remotely related information, may be the difference between success and failure. The volume of data that will be available in the future, due to the electronic data processing systems, will require the manager to have the ability to use wider bases of information on which to build his decisions. This ability to comprehend the relative significance of data and to form it into a decision pattern will be aided by some

of the operations research techniques we have been hearing about in this conference. However, it will require more mature judgment and a more analytical approach to decisions than has heretofore been necessary or even possible.

One final comment on the matter of the manager of the future is that individual performance will be judged more on how well one manages than on how many people one manages. Since the statistics referred to at the beginning of this paper indicate that we are going to have to get more productivity out of our organizations, this means that the number of persons under our management during the next decade may not increase, but our problems of managing and producing satisfactorily under these conditions will be multiplied many fold. This will bring about new standards against which to evaluate the manager's performances.

CONCLUDING OBSERVATIONS

What do we conclude from all this? Management in the electronic age is going to pose severe new requirements for human judgment. Decisions are going to have to be made more rapidly because we will have more frequent knowledge of the need for making decisions affecting the success of the business enterprise. The manager will have to make these rapid decisions from facts gleaned from a wider range of knowledge than was heretofore possible. This will have several effects. For one thing, an error in management judgment will become apparent more rapidly and may have a more significant effect than a similar error in today's slower moving business. On the other hand, the continuous exercise of good judgment will be more rapidly rewarding since new measuring devices will be available to determine how successful a manager is from day to day. The introduction of statistical and mathematical methods will require that the manager of the future have a different form of education than has been the norm for managers of the past. Some of the people who will be the managers of the future will have to obtain this education on the job, since they have already completed their formal schooling. Already many companies are embarking on intensive in-company training programs to bring this new knowledge to their management personnel.

Perhaps we can sum up this entire discussion by saying that the advent of electronics and the development of such management tools as documentation, operations research, integrated data processing and the like, is turning management from an art into a science. As in any scientific field, much exploration remains to be done. Those of us who have management responsibilities stand on the threshold of a bright but challenging technological advance in the science of management.

Impact of the Electronic Age on Management

by G. E. PRENTICE*

THIS is a time that tries businessmen's vocabularies. Words and phrases which formerly were used almost exclusively by the scientists and engineers are now, with more and more frequency, being uttered from the lips of the American businessman. Such words as **digital computers, magnetic core storage, microseconds, transistor,** and **magnetic tape** have become commonplace. New words and phrases are being coined to explain and glamourize new concepts of operations in the business office. Terms such as: **electronic data processing, information engineering, linear programming, integrated data processing, operations research, optimum programming,** and **automation,** all are being used increasingly.

The large scale computers are even being used to invent new names. For example, a large pharmaceutical house in New York recently used an electronic data processing machine to develop a complete dictionary of names suitable for assigning to new-found drugs. As might be suspected, the machine—which has no moral standards—came up with a few names that had to be edited before the dictionary was printed.

All of these new terms and names that are heard in the business world are part of a revolution that has been sweeping the United States and, in fact, the world, since the end of World War II. They are part of a revolution in the office that is transferring the routine drudgeries of reading, writing, computing, and classifying from the minds of men to the electronics of machines, just as the Industrial Revolution transferred the routine drudgeries of manual labor to the mechanical muscles of factory machines.

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AUTOMATION

Automation is a term not yet found in our dictionaries. It means many things to many people, but unfortunately, to too many people it means the magic and sudden solution to all the problems of the ages. Basically it involves the intelligent use of machines to relieve the human mind of the myriad of repetitive detail that is part of our complex industrialized economy. It is a way of work based on the concept of production as a continuous flow—a linking together of already highly mechanized individual operations. Automation will never result from an office machine **per se.** It will be the product of the blood, sweat, and tears of the methods and systems men of this and the next decade. From over forty years experience, we have learned that all office machines—mechanical, electro-mechanical, or electronic— are merely office tools and are no more effective than the skills and experience of their users.

Today you will still hear people say, "When automation comes . . . . ." Automation is not coming—it is here. In the public utility industry, pencil marks placed on meter reading cards eventually are transformed into a finished electric, gas, or water bill through a continuous flow of mechanized operations. In the automobile parts division of Chrysler Motor Company, a customer's order is transcribed to punched cards and invoices are written. A computer[1] then takes the data and costs the sales; inventories for up to five stock locations are adjusted; inventory balances are scrutinized by the machine and up to 30 decisions are made—such as action taken to order more stock or to decide to transfer stock from one location to a more strategic location; historical records are adjusted, new minimum balances computed, etc.;

[1]The IBM 702 is an example of this type of machine.

and finally, the accounts receivable ledgers are posted. The only time human intervention occurs is when the machines kick out a complete parts record because the problem is of such a character that human analysis is necessary. Even then, the machine identifies the part of the record it could not cope with so that action can be taken swiftly and surely. There are many other areas where automation and the application of electronic data processing is making significant strides.

IMPACTS OF MACHINES AND TECHNIQUES

The electronic age in the office is still in its infancy and in ten or twenty years, we will be better able to see and measure the full implications of its impact on business management. But, already several fairly obvious effects of these new machines and techniques have manifested themselves.

One should think of these impacts as challenges to management rather than as problems, for, generally if they are accepted as such, they will permit a better, more complete and more scientific job of managing. There are four of these significant challenges which this paper will deal with briefly in an effort to show what they are and what the management team is doing or must do to meet them—not only so that the electronic age will be compatibly integrated into our office routines, but so that the effects will be felt in our entire economy and personal lives.

Role of the Methods Man

Perhaps the most acute impact and the one needing the greatest immediate attention is in the area of methods and systems personnel development.

It has been found that there is a great dearth of systems knowledge in the application of the radically new principles embodied in the electronic equipment being made available today for accounting and record keeping problems. To get an idea of the problem, one can make a partial comparison among punched card equipment, or other types of conventional office equipment and the electronic data processing machines, the popular name for the much publicized electronic brains.

Conventional office equipment adds, subtracts, multiplies, and divides under the control of predetermined logic built into the machine. In punched card machines, for example, control is enabled by variations in the wiring of external control panels which call into play the proper internal functions needed to process a particular job.

The electronic machines of today[2] differ from electric accounting machines in that the logic controlling the manipulation of the data through the machine system is not built into the machine in a fixed manner, but rather the logic (machine instruction) is created or assembled by the user, fed into the machine, and stored in the machine's memory device. The term **logic** refers to a series of instructions which the machine can perform. Add, subtract, multiply, and divide are four of the instructions. Others are: read, write, and compare. The inherent ability of these machines to recognize differences as a result of comparing two factors, and then following a set of instructions given to it for this possibility, has caused people to facetiously refer to these machines as "brains." Actually, nothing is further from the truth. They cannot think, nor are they motivated in any way by instinct as are even the lowest forms of animal life.

However, it is this very difference, this very ability of data processing machines to perform deductive logic which requires the user to develop his machine instructions, his machine logic, his "program" as it is called, that presents the basic problem to the user. Whereas, in the past the punched card machine did

[2]The IBM 650, the Magnetic Drum Calculator, and the larger 700 series machines are examples of the modern electronic machine systems.

this work, today the methods man assumes the assignment.

A completely new profession has to be created in our society by this concept. It is a profession that requires the disciplined mind of the mathematician, the keen perception of the problem analyst, and the common sense that grows from a broad understanding of business methods work. The success of these new powerful office tools is largely dependent upon the development of this new profession. The demand far outstrips the supply and yet management must supply an effective answer. Probably the only answer to the problem is education.

But, the answer is not just to send people to school. Representatives of American industry, of the business machine manufacturers, and education leaders must get together and map an integrated educational program that will provide the type of trained people who are, and will be, needed to a greater and greater extent. This has been started to some degree. Conferences and seminars are being sponsored by colleges, universities, and industrial organizations to discuss this problem and seek a solution, but progress seems painfully slow when compared with the rapidity with which the problem is growing.

The Professional Manager

The second impact or challenge of electronic data processing is the hastening of a change in the manager himself. The era of the professional manager is upon us. This era has a parallel with the electronic age. The electronic age in the business office really had its start back in the 1930s when IBM announced the principle of mark-sensing, a device capable of reading a pencil mark and converting it to a punched hole utilizing the amplifying characteristics of an electronic tube. At about this same time, Edward R. Stettinius, Jr., deplored the failure of American business management to abandon its "catch as catch can" method of finding leaders and to adopt an orderly system for discovering, developing, and assigning executive personnel.

Now more than ever before, it is recognized that the continuing growth and prosperity of a company depend on the development of men today for leadership and responsibilities tomorrow. Accordingly, many firms are attempting through study and planned self-improvement, not only to raise their present level of managerial effectiveness, but also to assure the availability of able candidates for managerial jobs as present positions become vacant or as expansion opens up new ones.

A reporter once asked the engineer of the 20th Century Limited what he thought about while the train was slipping through the night at seventy miles an hour. The engineer replied, "I think about a mile ahead." Thinking "a mile ahead" is an essential of business success today. Indeed a mile ahead seems hardly enough when an event half-a-world away can have such an immediate and telling effect upon business development.

When the first giant IBM electronic data processing machine for commercial work was installed in April, 1955, an executive of the company was asked why they had decided to utilize this equipment. He stated that the most significant reason for their decision was that for the first time management had a tool which would permit them to plan their business by looking through the windshield rather than looking through the rear view mirror.

In taking on this machine, this company's management looked to its electronic installation to get from it information that had never before been obtained, and to make this information currently usable. Detailed monthly cost sheets are prepared for each product. These show not only over-all costs but also a complete breakdown of the factors that contribute to the cost and the degree of variance from the standard cost. This, let me emphasize, is for each product. Formerly, part of this infor-

mation, in lesser detail, required a large group of topnotch cost accountants approximately one month to prepare. But, most significantly, by the time the accountants had the figures and got around to pushing increased efficiency at those plants showing excessive costs, the reasons for the poor showing often had become somewhat hazy and real pinpointing could not be realized.

Now these same reports, in much greater detail, can be furnished by the seventh of the month. The same group of cost accountants, now mentally liberated, use them while the facts are still fresh in everyone's mind. As the cost accountants exercise tighter control, the operation becomes more profitable. They know they are saving money and they are functioning with much greater efficiency.

Managers are now facing a great test of their competence in automation. Its aim being to arrive at a mechanized process which will produce the greatest selection of products with the greatest stability, at the lowest cost and with the least effort, automation will inevitably increase the demands on the manager's responsibility, on his vision, his capacity to choose between alternate risks, his economic knowledge and skill, and his competence in making decisions. To sum it up, one might say the electronic age will require managers who are statesmen and who will lead by logic and foresight.

Bringing Science Into Business

The third challenge of electronic equipment to management, and it is one that will have an increasingly important impact, is making use of operations research techniques. Operations research is the application of mathematics and experimental techniques to whole operations in order to discover underlying causes and relationships. For the first time the possibilities of applying scientific methods to business management problems can be seen.

There is often no one best solution to a business problem but several good alternatives to be selected by the management to make policy decision. In electronics we now have a tool which can analyze the problem in its entirety with all of its complex interrelationships and present to management the best various alternatives for consideration and analyses. The actual final decision will have to include human business judgment and experience and take into consideration the over-all policies and planning established by the officers of the company.

For example, operating decisions on inventory levels, may well depend upon the consideration of whether to reduce the inventory in process; decrease the manufacturing cycle; stabilize the labor force; manufacture to order, to inventory, or a combination of all. Some of these aims are contradictory in nature, such as stabilization of labor force versus shortening of the manufacturing cycle, particularly if combined with either seasonal variations or inadequate or short range sales forecasting. What is required is a clear view of the facts to determine the best compromise solution.

Obviously, such decisions are being made every day by any company, big or small, as part of its business existence. But, the point is: Are such decisions as scientific as they should be? All too often, scientific decision is lacking because of a lack of facts and a lack of technique. Yet, electronic data processing machines can provide most of the facts needed if they are intelligently applied in a truly integrated manner. And the fascinating part of it is that these facts are obtained as by-products of processing the routine paper work.

To repeat, the tools for management to run business as science are available today. The problem is not technology but methodology. As one considers decisions involving more and more variables and more and more intangibles, one finds that knowledge of management science

is really not yet developed. Operations Research applied to these problems is at present in an embryonic stage. Very few companies have started to use these techniques and, actually to use a technique like linear programming, an electronic machine is practically a necessity. Management must achieve a breakthrough in business science similar to the one that has been made in computer development. The promise of the fruits of operations research techniques will provide the motivation.[3]

[3]Mr. J. E. Hogan, Foreman, Office of Electrical Engineer, Pennsylvania Railroad, has been using electronic machines for solving some of the Pennsylvania Railroad's business problems. He recently prepared a paper on "The Calculation of Train Performance and Related Problems by Use of Modern Calculating Machines" in which he states that the function of a railroad is to provide transportation. But transportation to be satisfactory and attractive must be not only safe and dependable but also accomplished in a reasonable length of time and reasonably close to the time shown in the tables. To accomplish this, adequate power must be applied to the trains. But railroads cannot afford to be extravagent; locomotives are expensive, and the bigger they are, the higher the first cost and cost of operation in wages, fuel, and maintenance.

Some of the typical questions or problems arising in the purchase, selection and assignment of locomotives and the make-up of trains are as follows:

1. How many cars or how many tons can a certain class of locomotive haul from "A" to "B" in so many hours and minutes?
2. If the time is fixed and the number of cars or tons in a train is specified, what must be the horsepower of the locomotive?
3. If cars are to be added to a train, what will be the effect on the running time?
4. With the addition or elimination of a station stop, what time changes should be made in the schedule?
5. How much time can be cut out of a schedule by eliminating a speed restriction, through improvement in track conditions?
6. If time is not the governing factor, how many cars or tons can a locomotive haul at a reasonable speed on the ruling grade, or in the case of a locomotive with elecrical drive, without damaging the electrical apparatus by overheating?

The answers to these and other related questions may be important with respect to potential purchases and utilization of locomotives and other railroad equipment or investment in track improvements.

Of course, in many cases answers can be obtained through observation, by road tests, that is, by the trial-and-error method. But this method may prove expensive to the railroad and possibly annoying to its customers. And, with road tests, when normal operations are most desired, an unusual or abnormal condition may arise to spoil the test.

Mathematical solutions have been found to be quite satisfactory in almost all cases. The factors involved are fairly well established, particularly in the case of electric and diesel-electric motive power. The output of such equipment can be predicted reliably.

This is just one small area where science is being put to work to help management.

Reduction of the Work Week

The fourth significant impact of the electronic age which should be of concern to management is the reduction of our work week. Today, one hears more and more frequently that a four-day work week is much closer than many suspect. Many companies are currently working 35 hours and 37½ hours a week. It would appear that a four-day work week in the foreseeable future is a distinct possibility.

The United States has always been a hard-working nation. Up until the end of World War II, a six-day work week was general. Today the five-day week is the rule. Tomorrow people may have almost as much time away from the job as we have on it. This leisure time will be wonderful, but one cannot afford to become soft. This extra time away from the job must be used constructively if we are to meet this challenge of leisure time which the electronic age is forcing upon us. Again, management should join forces with our educators to meet this challenge.

One of the important aspects of a liberal arts education is to teach people how to use profitably their leisure time. As people find themselves with more and more free time available for vacations, travel, sports, theatre-going, hobbies, and countless other leisure activities, they must be able to wisely choose those activities and engage in the ones which will be the most productive and constructive to their personal lives as well as their business lives.

CONCLUDING OBSERVATIONS

We have discussed briefly just four of the impacts of the electronic age on business management. One must understand that electronics or automation in the office means change, but it is not a

menacing development or one which has to be feared. It is, in fact, a concept which has already raised the nation's standard of living and has had a stimulating and stabilizing effect on our economy. It will continue to have this welcome effect in the future. The automatic age is still in its adolescent stage. There are many amazing and startling developments which will be made available in the very near future to make lives in offices easier, more interesting, and far more productive.

One example may be noted. An announcement was made recently by our company of a revolutionary development to a machine which we all today accept as a necessity in the business world—the typewriter. This new device is called a word writer. An electronic box is connected to the typewriter which allows the typist to press one key and automatically type a complete word or even a phrase such as "Yours very truly," "Dear Sir," "Referring to your letter," etc. Forty-two phrases can be pre-set up in the storage unit for use. This device is not yet on the market but it foreshadows the future when it may conceivably be possible for the business executive to speak into a microphone and have his letters and correspondence put on paper without the use of what we today call key-driven equipment.

This is an exciting era—a time of change. This new electronic age is giving us a new way of life—a happier, easier, and fuller life. Arnold J. Toynbee in his book, **A Study of History**, devotes a section to the subject "Challenge and Response," and indicates that throughout history, great nations have either risen to heights of glory or fallen into dust because of either their ability or lack of desire to respond dynamically to a major economic or environmental change. Before the benefits of this electronic age can be realized therefore, business management—all of us—must meet the challenge that it presents to us.

One must respond by keeping a constant watch on the business world to determine what new skills are needed and what changes must be made in job specifications as machines take away more and more detail and drudgery from the office clerk. One must also respond by guiding young people who have the ability into technical fields to fill these new jobs. There is, for example, a tremendous demand for mathematicians, physicists, and people trained in all the fields of business sciences and engineering.

Moreover, one must respond by keeping abreast of new innovations such as Operations Research and new machines which are obsoleting skills. Our methodology must be brought up to date so that the tremendous benefits which are available to us from the new technologies which are open to American businessmen can be fully realized. Even more emphasis must be placed on the value of education, and college educations should be made available to all who possess the qualifications—not just for the skills they will learn but also for the cultural standards they can achieve.

Finally, one should never lose sight of the fact that machines are not made to replace people. They are tools, tools made to be used by people to extend the capacity of the human mind; to help business management produce better products at lower costs; to provide better information for management so as to improve the stability of employment through better planning; to help management create new products to use and new industries which will be the major sources of new employment and the guarantee of an expanding, dynamic economy.

The Use of Electronics in Production Control

by A. D. RADIN*

MANUFACTURING management assumes with its title the responsibility for producing a quality product at satisfactory cost. In essence, management is allotted money to pay for the manpower, machines, and materials required to turn out goods. The issue then resolves itself squarely into the question of how the money is to be used wisely in terms of manhours, machine hours, and units of material. This can be assured only through successful production control, the maximum coordination of human and mechanical elements in the plant.

PRODUCTION CONTROL SYSTEMS

Although there is no package production control system guaranteed to fit all types of manufacturing operations, the answer does not lie in rule-of-thumb and on-the-spot methods in such widespread use today. Reliance on "hot lists" and "shortage sheets" is the negative approach to a problem, the solution of which demands that adequate provision be made for anticipated needs. At the other extreme lie the overelaborate procedures which require too much clerical time to maintain and have a tendency to bog down. In either case, the danger is in accepting the ineffectual system at face value and charging off the inevitable bottlenecks and overload to the over-all cost picture.

The establishment of effective production control implies the recognition of three basic premises.

First, production control is a management responsibility. This must be stressed to counter any theory which holds that controls affecting every operating component can be delegated below the top executive level.

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Second, production control is less a system than a philosophy requiring the fullest participation by all departments. Lip service to this concept is not enough. No department can exist exclusively in its own rarified atmosphere and contribute at the same time to the smooth progression of manufacturing operations.

Third, production control is the sum total of intensive planning and the measure of performance against plan. Results must constantly be evaluated in the light of objectives to determine whether any of the factors involved need reappraisal.

Electronic Production Control

One of the best means of putting these requirements into practice is by means of electronics. Electronics in production control is a gathering, calculating, and reporting tool which is capable of serving more than one function with respect to a single document and producing all related reports from the same source of information. Thus, all subsidiary calculations are derived from estimates recorded on punched-cards as standards. These estimates are realistic—submitted by the departments concerned in terms of their known capabilities.

Among the interconnected functions of production control are: electronic service order scheduling, order explosion, inventory control, machine load forecast, and shop expediting.

For example, a system of data processing provides for a new concept of production control administration, operation and record keeping.[1] In an eight-hour day, up to 100,000 unsorted items (de-

[1]In terms of the usual punched-card procedures, the Univac File-Computer eliminates many manual or machine steps required for matching new data with related file data. It eliminates the need for sorting, merging, collating, reproducing or pulling cards from a tub file before the processing can begin, and does away with the necessity for waiting until an economic batch of data has been accumulated.

pending on the type of data) can be entered in a file-computer in order of arrival, each matched automatically with its related file data, and processed as needed to finish several record-keeping tasks in a single program. Complete file data are available instantly from any of the magnetic drum file locations. The total file capacity and the standard size of the file locations are determined in planning the applications.

This is just one example of the use of the file-computer in a machine loading and scheduling operation. (See Fig. 1).

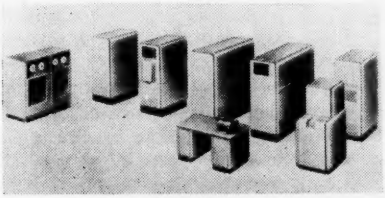

FIGURE 1

The new Remington Rand Univac File-Computer System, which introduces a new concept of accounting and record keeping for commerce, industry, and government. It features random access to information stored in the magnetic drums; the data are made available at micro-second speeds, merely by pressing a button. It combines magnetic drum storage and electronic computing techniques, and is applicable to a wide variety of data processing situations.

Master operations decks of punched cards or master tapes would be pulled from file. These cards or tapes would be fed into a file-computer, where standard hours required are electronically extended, and start and completion dates automatically computed. Productive time required by weeks or manufacturing periods can then be referred to the proper location in the magnetic drum storage to load hours to existing backlog. The machine can be programmed to signal overloads in any given week, or to reject cards indicating jobs affected by the overload condition. Immediate read-out is available to provide constant information as to the condition and spread of backlog in the plant.

This scheduling and loading is done with the data in job order sequence. It is not necessary to sort the data by department or machine center. If an overloaded condition is indicated, all operations cards pertaining to a specific order are together, thereby eliminating the time consuming job that must be done by present methods to find all operations cards for a specific order, and bring them together before rescheduling.

Information on jobs comprising the load can be sorted on the drums and drawn off in the form of printed reports to act as shop schedules. In addition, tabulating cards used as input media to machine loading can also be utilized to prepare job tickets.

After work has been completed in the factory, the results of production achieved, quantity completed, and actual time can be punched into the job cards, and the cards fed back into the computer without sorting to record production achieved against quantity scheduled. (See Fig. 2). This information can be

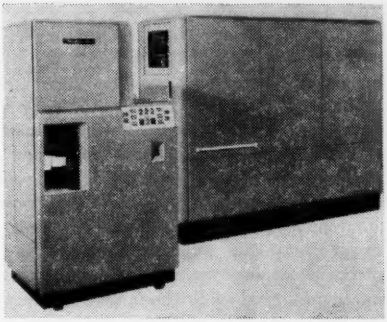

FIGURE 2

Remington Rand Univac 120 Electronic Computer. A punched-card electronic computer that solves complex problems of business record-keeping and scientific mathematics in fractions of seconds. Processing up to 9000 cards an hour the Univac 120 carries out complicated programs of many steps that would require numerous operations on other machines. Makes logical choices to vary the program as required. Repeats a step or a series of steps in any sequence. Uses different values or makes different computations in the same step. Automatically checks each step for accuracy.

drawn off in the form of daily production reports for distribution to all interested parties. Because this data is readily obtained at high speeds, this type of installation provides a solution to

what has previously been a knotty problem in obtaining current and timely daily production reports. (See Fig. 3).

FIGURE 3

The Remington Rand Univac in action, showing the Central Computer in the background and in the foreground, the Supervisory Control panel, which gives the operator a continuing picture of the operations of the computer. The control printer, at the right behind the operator, is used for printing out spot results, or to permit the computer and the operator to communicate with each other. The mercury memory, in which all information being processed is stored for instantaneous access, is inside the Central Computer cabinet. At the right are the Uniservos, high-speed tape-handling mechanisms that feed information into the computer, and take away the finished results. One reel of Univac tape holds 1,500,000 alphabetic or numeric characters. Auxiliary equipment for preparing this tape or printing out the results is not shown.

In the control of raw materials and component parts, and supply assembly inventories, the file-computer makes available an electronic method of recording inventory data without need for prearrangement of data in numeric sequence. Pertinent data as to requirements, open replenishing orders, available balance, and actual balance can be stored on the drum. Input information can be fed directly to the computer, whose immediate access is available for reading out the position of any item of inventory. The computer can be programmed to signal quantity below the review point, exceptions, and to report those items that are critical. In addition, a requisition can be price extended and inventory relieved in one operation, without putting the cards into any particular sequence. For companies with heavy daily activity of incoming orders, both of these functions can be performed simultaneously.

CONCLUDING OBSERVATION

One reminder is always in order when describing the part played by electronics or any complex mechanical system. It is simply that machines do not think. Even the most accurate of machine-made reports must be supplemented by human judgment and initiative; otherwise they are worthless. The results measured against the objectives must be freely communicated among the personnel who are in a position to recommend or take action. Electronics is the operating tool which enables this to be done on the basis of yesterday's daily production report. Production control is the management concept which, if properly fostered on the operating level, encourages all concerned to use such tools as an adjunct to, rather than a substitute for, human ingenuity.

Sales Forecasting and Economic Planning

by HERBERT M. LIVINGSTON*

DURING the past few years a definite change has taken place in the planning and control functions of modern industry. Facts and figures are being substituted for guesswork and estimates; analysis is being substituted for intuition; future performance is being predicted with far greater certainty than ever before. The key to a successful planning and control function is the sales forecast. The advent of electronic data processing at a time when forecasting and economic planning are receiving greater emphasis is fortunate due to the functional relationship of normal day-to-day business operations, forecasting, and planning and control.

SALES FORECASTING

This paper deals essentially with sales forecasting and economic planning. First, one may ask, "What is the importance of sales forecasting?" "Why is it necessary to have economic data and industry trends and to prepare forecasts or predictions of our future operations with such precision?" Sales forecasting and economic planning are essential in our competitive market today in order to be able to provide the products consumers want when they want them, and at the lowest possible price.

The technological aspects of business engineering are extremely complex. Only recently has any emphasis been placed on this problem. The technological aspects of mechanical engineering and aeronautical engineering are well known and in a high state of refinement. With the wide usage of scientific electronic computers today none of the aircraft or engine manufacturers would consider building or putting into production a model that had not been analyzed and mathematically test flown to determine its performance and behavior.

Why isn't this equally as important in the business side of the picture? The wind tunnel for a newly designed aircraft helps detect and correct errors in engineering judgment and decision. The "wind tunnel" for testing management decisions in a business is the day-to-day operation, and the results mean either success or failure.

The emergence of operations research and linear programming techniques are rapidly becoming the wind tunnel for management decisions and for testing the validity of sales forecasts. The trend is toward objective forecasting rather than on a concensus of executive opinion.[1] Forecasting is more and more economic, business, and industry factors. It has to be if it is to be useful for production planning, raw material ordering, budgeting, and the like. Most aggressive companies today are realizing the need for an objective analysis of all the relevant facts to arrive at a detailed forecast that will come close to actual performance.

Who Makes the Forecast? In the past this was the function of the president or chairman of the board and perhaps one or two vice presidents. Today there is a trend toward a larger committee of management-level people usually under the coordination of a senior marketing executive.

An indication of what can be done for sales forecasting and for economic planning is indicated by some of the most recent activities in other related fields. One outstanding example is the **Standard and Poor's, 500 Stock, Elec-**

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[1]In the past, and many companies are still doing this today, the sales forecast was based on an average of estimates submitted by the sales force and company executives. This technique is dangerous unless the company is in an industry enjoying a sellers' market and a backlog of orders can provide a cushion to absorb errors made in the forecast.

tronic Index. One of the biggest services of this electronic index is that it will supply a figure which is relatively close to the actual per dollar or per share dependent upon a scientific analysis of value of a stock. In the past this has been very difficult to achieve.[2]

Another example was cited in the February, 1955, issue of **Management Review** with regard to sales forecasting at the New Departure division of General Motors. The sales forecast is the very heartbeat or pulse of this entire operation. It is used, for instance, to do their expense and profit planning and budgeting, as well as for production scheduling, inventory planning, manpower scheduling, equipment and facilities planning, sales planning, and to establish sales quotas. Profit and expense plans are also developed from the monthly forecasts which are projected four months in advance. The annual forecasts are used for budget development, determination of plant facilities requirements, and for determining sales quotas.[3]

[2]This program was developed jointly by a group of young engineers at Melpar in Boston and Standard and Poor's for the Datatron Computer. The Melpar group developed a converter that duplicates all transactions on the big board ticker into a special tape that is then simultaneously read into the Datatron Computer. The Datatron selects from all stock transactions only the 500 stocks that make up the index. The computer then derives the basic index data by multiplying the price of the stock by the number of shares outstanding.

According to the publicity that was released, the one o'clock hourly index was printed at one minute after one. This is an indication of the rapidity with which the calculation is performed and the interrogation is executed in order to determine which stocks are in the index and the number of shares outstanding.

[3]It is interesting to note the way information is obtained for the forecast. Their representatives deal directly with the customer during their regular calls and on an informal basis get a projection of his requirements. This would appear to be a very accurate forecast in that the customer not only will provide his comments on his future needs in general, but will also go into detail with regard to specific sizes and types of items. This information, of course, can then be compared against the orders in the past and the true forecast picture derived. Then by properly combining the economic forecast of business in general with the statistical indicator, an estimate of future company sales is obtained.

Economic Planning

One of the leading questions is "How can general economic planning or forecasting help to make wise decisions in a company?" It is difficult to relate many of the indicators that are used in forecasting and planning. There is disagreement between the various trends that are published by the various trade journals, but the important thing is that a forecast is a result of planning by management, and it is this planning and working together and obtaining better conceptual knowledge of the over-all operation that is significant. Just what is the meaning of sales forecasting and economic planning? Why is sales forecasting of such utmost importance in our business world of today? Which precedes the other and how are they related?

Sales forecasting, on the one hand, is determining the market potential for the company. The sales forecast is the over-all picture or the indication of where the company is going in the next year, two years, or five years. It indicates the growth factor or decline of the company.

After the sales forecast is prepared, it is the function of the planning staff to take the economic factors into consideration and take the market potential of present products into consideration to determine just what new products will be required to meet this sales forecast.

One of the problems in economic planning that confronts many of the economists today is the determination of the proper indicators to use in predicting the future. The determination of the functional relationships between the indicators is also a problem that has been baffling the economists for many years. Modern-day computers now offer a solution for these problems.

Many of the economic studies of today are based too heavily on the general or over-all view. They are not based enough on the activities of the specific industry. It is necessary to have a clear picture or a better conceptual knowledge

of what is happening in a specific industry, in a specific company, and then tie this in with the over-all economic picture in order to come up with a realistic forecast.

Another interesting type of forecasting or predicting that has been done is of election returns. Few people appreciate the significance of this kind of prediction or forecast. The calculation or prediction of the election return is analogous to studying the economic picture for a company or an industry. It is entering into the computer the various statistical data, the historical data, and predicting on the basis of this information what the future is going to hold. Of course, it is not as easy to predict or to use such techniques for economic planning as it is for predicting the weather or the outcome of football games.

Those companies which are not doing planning and are not looking into the long-range picture are really undergoing deliberate, subconscious liquidation. They are too busy trying to make a profit today to figure out or think ahead as to what the company will be doing five years hence.

One of the problems that small companies face today is that they cannot afford to make costly errors as can their larger competitors. They do not have the working capital to absorb any costly errors that are made in their planning; therefore, it is extremely important that the smaller companies operate on a sound basis and do very careful planning and forecasting.

Company presidents or chairmen of the boards have not had the time nor the facilities to study all the details and take all of the ramifications into consideration for long-range planning. Many think in terms of volume rather than of making more effective use of their present resources by improving operations. They think in terms of going to new products rather than developing their old ones; new lines of business and increasing the number of lines rather than in making a greater margin of profit on the products they now have. This is all part of what the long-range planning picture reveals to management.

It is not impossible to look into the future and see functional components of large data processing systems which will be designed primarily as special purpose equipment, the function of which will be to perform the necessary computing and to carry out the necessary technical calculations, to arrive at a business forecast or a long-range planning activity for the future. This could be a very intricate system not only based on digital techniques but also on analogue relationships existing between the various business functions that would be determined by the system. In the not too distant future it is likely that special purpose computers will be solving business problems before management is even aware that these problems exist. This is the optimum answer, of course, to solve the problem before it exists.

Today we are a long way from what we had yesterday, last year, or five years ago. We are now doing complete sales forecasts on digital computers. We are making distributions by various categories to assist in making predictions as to what stock to carry or as to what the low level mark should be or when to reorder, and what the minimum quantities should be on inventory items.

TOOLS FOR FORECASTING

The tools for forecasting are becoming extremely flexible. They are functional, they have expandable features and the units are designed today to operate independently of each other. The various units of the system can also operate simultaneously with other units in this system.

The small desk size electronic digital computer that many companies are using is perhaps the first worthy of mention.

This is essentially a modern day version of an electronic desk calculator. It is a problem solver,[4] and is being used more extensively for technical calculations, for the solution of everyday technical problems that arise in business rather than for those in the data processing area.[5]

The large computers which are used for sales forecasting and economic planning problems also need some discussion. Computers again are nothing more than aids as tools for the economist or the planners that are coming up against these vast problems. They are used to solve the problems that involve a tremendous number of unknowns.

Computers today are being designed primarily for solving business problems and specifically for data processing. Some have the ability to read simultaneously from several card input units, also simultaneously print or punch on several output units. These can also be operated in some cases while the machines are doing computing. Many other devices and usages in combination functions are possible if the proper programming and machine system design can be established.[6]

There are computers on the drafting boards today that will perform millions of operations per second. They will have storage capacity that will far exceed the storage capacity of the systems available today. It is almost impossible to conceive what the future holds.

But now, how does one use these powerful data processing machines for solving forecasting and economic planning functions? May one be called upon to be responsible for performing the programs for setting up these problems? This is a tremendous responsibility in that the person selected will be planning the future of the company.

This will perhaps be an evolutionary kind of thing. Procedures and techniques will be developed because of the tools that are available. This will lead to a system of planning and forecasting that will not be the primary responsibility or function of one person or a small group but rather will be dependent upon or will result from a series of evolutionary developments. For instance, with an extremely fast, extremely large computer that can store vast volumes of information, one could examine all possibilities of what action should be taken based upon existing conditions, and could get all of the interfunctional relationships between all of the variables while letting the computer make its

[4]An example of this type of machine is the Burroughs E101.

[5]For example, it is being used for determining quotas in our own branch offices. We enter into the computer the annual quota for the particular branch office. This quota is then subdivided by product line and by line of business for that particular branch. The annual quotas, previously set, are associated with each office by product line. These are adjusted annually to take the market trends into consideration. The quota for the branches is inserted in the keyboard of the computer. It multiplies this quota by each of the percentages for the product lines and determines what the quota will be for each product line. It also obtains the breakdown of each of the product lines by type of business and the percentage of each of the product lines which will be sold to each industry by month throughout the entire year.

This is a good application for a small desk size electronic digital computer. This machine functions either 100 or 220 words of drum type memory. It has 128 program steps on eight separately removable pinboards. The data is entered either through the keyboard or through a punched paper tape input-output unit. The outstanding features of the machine are that it is easy to learn, easy to use, and it is rapid and automatic. It does not require a special operating staff. It has been far more valuable as an instruction tool than we had ever imagined.

[6]The Burroughs Datatron is an example of this type of machine Another is Datafile, a rapid access magnetic tape system, that can operate independently of the card input-ouput units. The Datafiles can provide a maximum capacity to the system of 200,000,000 digits. It has independent tape searching. It has features for updating records. Each Datafile has a capacity of 20,000,000 digits and one unit can be set aside for storing statistical information.

In addition to the Datafile and Cardatron systems there is a central computer or data processor. This has a memory capacity of 4,080 ten digit numbers. This is adequate capacity for performing many of the business operations, such as sorting, sequencing, etc., internally. This combined with merging operations using the Datafile provides a very effective medium size data processing system.

The Datatron is one example of what is now available in the medium priced, medium sized field.

own tests based upon the criteria fed into it. In this way it would arrive at the best solution to the problem.

What approach do many companies today use in solving their sales forecasting problem? First, the necessary data related to the problems is gathered; second, certain estimates and plans as to what the products will be are made; third, assumptions as to production facilities available, personnel available, existing transportation system, normal profit functions, and existing relationships within and between each product or product line are made; and finally, a specialist or expert on linear programming or person who is thoroughly familiar with operations research is called upon to set up a model to determine what the optimum operation would be to obtain maximum profit on a good sound operating basis.

One may consider what this means. First of all, the organization, the company, or the industry that is dependent upon this has gathered the data, has done the analysis and has done the work with regard to setting up the functional relationships that exist. They have gone to the point where they are then in a position to evaluate better the over-all situation than the specialists. Specialists in linear programming and operations research are merely using a technique to carry out the final details. The companies themselves, because of this fact, may soon be conducting their own linear programming operation and have their own operations research departments. Many companies today have this. They are made up of executive caliber people in very responsible positions, who have the conceptual knowledge and ability to see the over-all picture and to determine how or what the functional relationship between the various operations is.[7]

[7]For example, Sears Roebuck and Company has been using computers for inventory forecasting in their various offices. A regression equation is arrived at through the method of least squares. This is then projected on a straight line to obtain the inventory forecast.

CONCLUDING OBSERVATIONS

The increasing complexity in the technology of production facilities makes long-range planning a necessity. Time is required to design, produce and install the ever more complicated production equipment. It takes a longer lead time; it takes longer to perform the set up and planning and scheduling than has been required in the past.

It seems extremely important to point out again the importance of the executives and management doing the forecasting and planning and thinking through the problems. The development of ideas and the use of brain-storming tactics make it possible for them to see more clearly just what the future holds and what some of the problems are.

There is today a great need for technically trained people, and there is a great desire by companies in the field to call upon the computer manufacturers to provide them with personnel to put the equipment into use. It is extremely important that these companies recognize that their own people should help to solve these problems and that the computer companies should act merely as advisors. The employees of the company or the organization using the system know and understand the problems and must solve them to survive.

Business forecasting helps one to know in advance what is coming; economic planning if properly carried out helps one to know what some of the coming problems are, and can help one to determine the over-all outlook. The future is an out-growth of the present and an extrapolation of the past. If one can predict the small changes of today and have an understanding of what these small changes mean and then apply trend factors to predict the future, more realistic predictions for the future may be possible.

It is also important to point out again that economic planning follows forecast-

ing. Forecasting is the first function in obtaining an over-all picture. It is a projection of where the company is going. Economic planning involves taking the forecast and applying the economic factors to determine just how to use this forecast.

Computers will lead to making more and better short-term predictions. Computers will provide a better control for manufacturing and business processes. Computers will allow reduction of the amount of inventory required, and minimize the time or the delay between the end of the production line and the consumer. Computers will allow the company to operate in a more efficient manner in that management may be able to see or to determine the relationships between the various activities in the company.

Philadelphia Business Index

The September 1950 issue of the Bulletin presented a new index of general business conditions in the City of Philadelphia. This series, prepared and since maintained by Robert T. Kline, was designed to reflect economic activity exclusively within the boundaries of the City of Philadelphia. It was originally based upon a combination of statistical data representing (1) industrial electric power sales; (2) indexes of employment and employee-hours; (3) department store sales[1]; (4) bank debits[2]; and (5) total construction. Because the method of reporting certain data is under revision by the originating agencies, the change in average weekly hours worked and the monthly change in total employment in the Philadelphia metropolitan area, both prepared by the Department of Research of the Federal Reserve Bank of Philadelphia, have been substituted for (2) above. This is a temporary expedient to maintain continuity of the index. The original data series will be restored after revision.

The following table presents the index for the years 1939 through 1956 and by month from September, 1956.[3]

Index of General Business Conditions, City of Philadelphia, 1947=100

Year	Index	Month	Index
1939	73	1956	
1940	77	Sept.	133.7
1941	96	Oct.	128.7
1942	99	Nov.	126.0
1943	106	Dec.	125.0
1944	106	1957[1]	
1945	98	Jan.	124.0
1946	100	Feb.	125.2
1947	100	Mar.	123.8
1948	103	Apr.	125.6
1949	97	May	129.9
1950	108	June	131.7
1951	111	July	132.9
1952	111	Aug.	133.1p
1953	119	Sept.	133.0e
1954	119		
1955	124		
1956	128		

p=preliminary
e=estimated. Based on currently published weekly indicators.
[1]A minor revision in the seasonal indexes has resulted in some slight changes in the 1957 monthly data.

[1]The revised index of Department Store Sales, published by the Federal Reserve Bank of Philadelphia, has been used in the composite index since October, 1951.

[2]The revised Wholesale Price Index, all commodities, published by the BLS, is used beginning January, 1952 as a deflationary index for the Bank Debit Series.

[3]Kline, Robert T., "A Measurement of General Business Conditions in the City of Philadelphia." **Economics and Business Bulletin,** Temple University School of Business and Public Administration, Philadelphia, Pa., September, 1950, pp. 33-40.